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UNITED STATES AND THE CONTINENT

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CHAPTER VI.

LEPROSY.

By ISADORE DYER, PH. B., M.D.

Synonyms.—Lepra; Elephantiasis Græcorum, Hebræorum; Leontiasis; Satyriasis; Ophiasis; Tzaraath (Hebrew); Kushta (Indian); Juzam Dofil (Arab); Fa-Fung, Ta-ma-Fung (Chinese); Boasi (South American); Lebbra (Italian); Radesyge, Spekalshed (Norwegian); Aussatz (German).

Definition.—Leprosy is an endemic disease, contagious in type, due to the direct presence of the *Bacillus lepræ*, which in its development produces structural changes in the skin and mucous membranes, nerves, bone and other tissues, usually resulting in more or less alteration in the configuration of the tissues involved, at times causing actual deformity and mutilation.

Historical.—The early history of leprosy is obscure, even confusing. The Bible references¹ to the disease are sufficient to establish its existence, but the descriptions are inaccurate and the leprosy of ecclesiastical literature seems to have been generic for a number of skin affections. Both the Talmud and the Koran take cognizance of the disease and apocryphal writings discuss it. Knowledge of early leprosy appears to have restricted the disease to Egypt and the Orient and in India the disease was recognized as early as 1500 B.C. In 600 B. C. the Persians instituted measures against leprosy (Leloir).² As early as 636 A. D. lazarettos were established in Italy. In the tenth century the islands of Great Britain were afflicted. In the eleventh and twelfth centuries the disease spread all over Europe, directly attributed to the returning crusaders. Measures were adopted for its control, chiefly consisting in the establishment of leprosariums. Of these it is stated there were 19,000 in Europe, and 2,000 in France alone. The colonies of European countries suffered next, until to-day there are few lands free of the disease and it is estimated that there are nearly 3,000,000 lepers in the world. Of these, the largest number is in China (estimated at 2,000,000); the next is in India (estimated at 200,000); while the other parts of the world afflicted are the following: Japan (20,000 known lepers);³ Northern, Eastern and Southern Africa; Madagascar; Arabia; Persia; Russia; Norway; Sweden; Italy; Greece; Spain; (Germany, France and Austria, excepting Hungary, are practically free of the disease); the islands of the Pacific and Indian Oceans. Leprosy is also endemic in Central and South America. The United States of Columbia, Ecuador, Venezuela, Brazil, Chili and Peru have each recorded statistics concerning the disease. In Mexico and in almost all of the islands of the West Indies leprosy is found and in most of these provision is made for it.

In North America a number of the United States are involved, notably Louisiana, California, New York and Minnesota. In Louisiana the disease

¹ Exodus IV, 6; Leviticus XIII, 24, 25, 43, 52; Numbers I, XIII; Deuteronomy XII.

² Leloir: *Traité de la Lèpre*, Paris, 1885.

³ *Transactions of the Berlin Lepra Conference*, 1897.

is endemic, occurring almost wholly among the native born or persons long resident in the state, while other centres show simply an increasing number of cases in recent years. Since 1905 about 400 cases have been recorded in the United States.¹ New Brunswick in Canada, at Tracadie, and British Columbia, at Darcy Island, have a few cases.

The numerical importance of the disease has carried considerable force with various governments to the end that legislative action, aimed at segregation, control and treatment, has become general. In some countries the provisions are fulfilled under private charity but for the most part government provision of funds has accompanied the execution of enactments. These results have followed the Berlin Lepra Conference of 1897 and in all countries an intelligent effort is now being made to accomplish a better knowledge of leprosy and its eradication, through sanitation and treatment.

Etiology.—Contagion.—The consensus of opinion has accepted the *Bacillus lepræ* as the cause of leprous lesions and their effects and the evidence points to the introduction of the organisms of the disease through the nasopharynx. This theory is strengthened by the absence of an initial lesion of leprosy at any particular point of inoculation, the absence of specific inoculation or the history of such, and the frequent occurrence of the disease under conditions which favor the inhalation of the disease-bearing secretions from the original case. Frequent cases in the same family, the spreading of the disease in districts and in cities, countries, and states, suggest the more likely spread through the respiratory tract.

Among those who have strongly urged this theory are Goldschmidt, Morrow, Sticker, Jeanselme, and others (Babes, Gluck, von Peterson) more recently. Emilio Martinez, of Havana, personally stated to the writer that in almost every patient with leprosy he had been able to examine, he had found an early excoriated lesion in the nasal mucous membrane showing the bacilli of the disease.

Heredity.—Heredity is still held a factor by a few observers but the vast majority have dismissed it as a consideration. The results of the British Leprosy Commission in India in 1893 showed less than 3 per cent. of cases developing among children of lepers removed at birth and these showing the disease after the third year; the absence of any record of a leper born as such in any of the many centres of the disease still places the burden of proof on the few who claim this as a factor.

Race.—Race undoubtedly bears a close relation to the spread and to the element of susceptibility to the disease. Records in almost every country show the native born the most frequent victim while the foreigner is slow to acquire the disease. This is particularly exemplified in China, Japan, India, the Hawaiian Islands, the Philippines, Colombia, the Polynesian Islands, Madagascar, Mexico and Louisiana. There is no doubt, however, that the likelihood of exposure to contagion is more apt to occur in the family and community life among these, and this must, therefore, be taken into consideration.

Diet.—Quite a number of leprologists have urged diet as an element in the spread of leprosy and the prominence of some of these protagonists demands a consideration of the theory. Jonathan Hutchinson has supported the fish origin of leprosy for many years. His observations and deductions

¹"Leprosy in North America" (Dyer), *Transactions International Dermatological Congress*, Berlin, 1904. The author's notes record 219 cases in Louisiana.

have been almost entirely derived from British India and as yet the theory is unproven. Ashmead, Blanc and others have expressed a belief that fish may be the occasion of leprosy. Hutchinson propounds the idea that leprosy occurs chiefly in India among fish-eating peoples who are not particularly careful about the freshness of the food; others argue the possibility of fish acting as the intermediate host for the leprosy bacillus. As yet no one has discovered the bacillus of leprosy in fish or in any other food supply and the disease occurs alike in those who eat fish and those who have no fish to eat. Almost as a unit the students of leprosy in India, the Hawaiian Islands and in other leper centres deny the evidence of any such origin. The observers in India point rather certainly to widespread occurrence of the disease among those castes who by religious obligations are forbidden fish.

Diet in its relation to the individual leper is another matter and particular emphasis is laid upon its importance as it may affect the resistance or otherwise to the disease.

The habit of oral feeding of infants in the Hawaiian Islands and the family promiscuity in eating "poi" with the fingers is held as possibly accountable for the spread of the disease by contagion.

Climate.—Warm climates evidently favor the development of leprosy but it occurs in any climate as is exemplified by the long prevalence in Norway, Sweden, Iceland and Japan. Seaboard countries seem to have suffered most from the disease but this is easily accounted for as these are naturally most exposed through their ready intercourse with infected countries through ordinary ways of commerce. Leprosy spreads, however, in every country where it is introduced. Where community life, hygienic environment and standard of metabolism are high, the disease does not spread rapidly.

Vaccination.—Vaccination has been discussed as a probable method of the spread of leprosy but no proof has followed the tentative theory and in these days of bovine virus such a likelihood is precluded.

Insects.—Recently the proposition has been made that fleas might be the medium of spreading leprosy. Mosquitoes, bedbugs, and other accidental parasites attacking the human body have been considered in the same way. Nuttall reviews the various opinions on this point, and considerable work was carried on by the British Leprosy Commission without result. Within the past six months, E. S. Goodhue, of Honolulu, Hawaiian Islands, has announced the finding of the *Bacillus lepræ* in mosquitoes and in bedbugs.

Other Diseases.—Fitch of San Francisco and some adherents argued the possibility of leprosy as a "fourth stage" of syphilis, but so many cases of syphilis contracted by persons already lepers have been reported that the theory has fallen, even if other evidence had not sufficed. The identity and correlation of leprosy and tuberculosis is a more recent idea which has been rather ventured than tried.

While the contagiousness is capable of only indirect proof the vast amount of evidence points to this as the sole method of spread of the disease, and as more exact opportunity is now afforded to study early cases, it is likely that an initial lesion may be found, particularly as that has already been suggested as probably present in the nasopharynx.

Pathology.—Every evidence of leprosy in the human economy is essentially due to the lepra bacillus, no matter what organ may be affected. This has been firmly established since the original discovery of the bacillus by

Hansen in 1868. The *Bacillus lepræ* is described as a small rod bacillus, from one-half to three-quarters of the diameter of a red blood corpuscle in length ($\frac{1}{5000}$ of an inch) and in breadth about one-fifth the length. According to Cornil, the largest are found in the parenchymatous organs, while in the skin lesions they are less developed owing to compression. The bacillus is straight or slightly curved, with pointed or rounded extremities. It occurs in short chains or beads, resembling the tubercle bacillus, and may have its extremities club-shaped (Byron). The lepra bacilli are more abundant than the tubercle bacilli and are more frequently found in clumps and masses in the tissues and are more readily stained with the usual methods. In instances of doubtful determination, inoculation experiments establish the diagnosis of tuberculosis and exclude leprosy. Arning's inoculation experiment with a Hawaiian leper (Keanu), in 1884, has been discredited owing to the strong probability of contagion from near relatives who were lepers.

In animals, Damsch, Campana and Vossius succeeded in reproducing the disease *in loco*, but not generally. Melchior and Ottmann succeeded in distributing the disease to the visceral organs, etc., following the introduction of a freshly extirpated leprous tubercle into the anterior chamber of a rabbit's eye. Experiments with the human subject have been rare and without authoritative verification (Daniellson and Boeck). The bacillus may be found in almost any tissue, but is selective of particular organs, tissues and regions. The bacillus occurs in the nasopharyngeal and other secretions, the saliva, the fæces, vaginal and urethral secretions, and in the semen, milk and sweat. Sticker claims that the presence of the bacilli in such large numbers in the nasal secretion commends the early examination of this as a means to diagnosis. The fluid from artificial blisters as well as serum drawn from deep tissues have been examined for the bacilli with positive results.

The smears from these secretions and fluids are dried and fixed in the ordinary way and stained with carbol-fuchsin, as for tubercle bacilli, decolorized with a weak solution of acid (3 to 5 per cent.), completed with alcohol and counter-stained with methylene blue. The cigar-bundle shaped masses take up aniline stains (Gram method) at the room temperature and retain them tenaciously. Unna recommends staining in a twenty-four hour old Ehrlich's solution newly filtered for twelve to twenty-four hours at the room temperature or one to two hours in the incubator, wash for ten minutes in water, and place in 20 per cent. nitric acid until greenish-black. Wash in absolute alcohol until pale blue and in water until colorless; dry and mount.

Attempts¹ at culture of the bacillus have met with varying results. Byron made a pure culture in agar-agar. Bordoni-Uffraduzzi, Babes, Czapslewski, Spronk and Kedrowski claim to have succeeded. The organism grows slowly and the cultures resemble those of the tubercle bacillus. The organisms, however, differ from those found in the body in not being acid-fast and it is questionable if they are identical. The media used were mixtures of blood serum, peptone and glycerine. The glycerine seems to be essential.

The bacilli are widely disseminated throughout the body, having been found in practically every organ and including the peripheral nerves, spinal cord, brain, and in the skin (even in scrapings of the skin), interstitial con-

¹ Babes: "Die Lepra," Nothnagel's *Pathologie und Therapie*, XXIV Bd., 1901, Wein. (A very complete bibliography on leprosy is given.)

nective tissue and in the muscles. In general the number of bacilli has no relation to the severity of the accompanying tissue changes.

Scheube¹ gives a comprehensive summary of tissues where the bacilli have been observed:

The skin and mucous membranes, earliest in the anæsthetic patches.

In the peripheral nerves and lymph glands, especially in the sheaths and in the lymph gland secretions.

The internal organs involved are the lungs, liver (especially the liver cells), the intestines, kidneys and lumen of the urinary tubules, the testicle, its tubules and ducts, and the ovary.

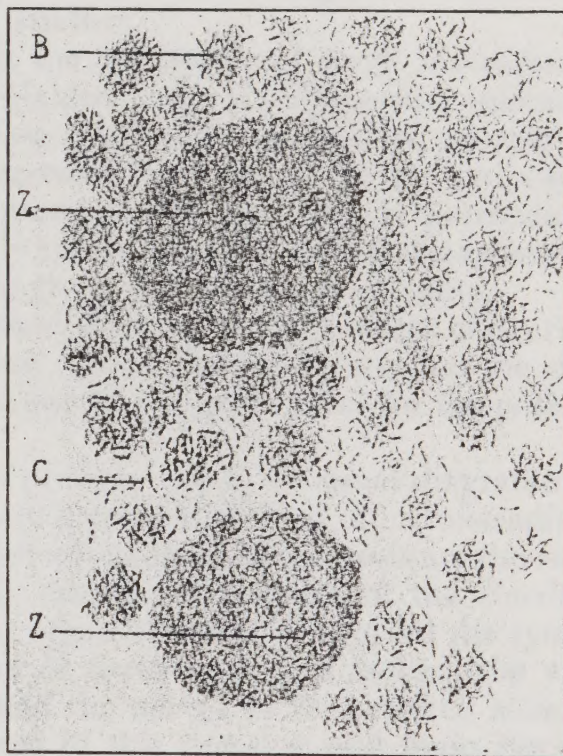
In the tonsils, the eye, in the sweat glands, hair follicles and sebaceous glands between the epidermal cells, and in the arrectores pilorum the bacilli are found.

The connective tissue of the cutaneous nerves, in the Pacinian corpuscles, the salivary glands, pancreas, adrenals, spleen, larynx contain the organisms. They are also found in the substance of the brain and cord and in the Purkinje cells of the cerebellum; in the choroid, retina and ciliary body; in the muscles and tendons, and in the periosteum, bone and medulla. In the acute stages of leprosy, the bacilli are found as contents of the blood cells and in fluid lesions of the disease. The bacilli are very numerous in the infiltrative tissues, and in nodules and tubercles, but in the erythematous patches and nerves they are scanty.

Outside the human body the bacilli have been found in the habitations of lepers and in the ground over lepers' graves. Various fish have been examined for the bacilli but with negative results.

The leprosy nodules belong to the group of granulation tumors and are similar to those of syphilis and tuberculosis. Microscopically they consist of a small amount of fibrillar connective tissue with numerous cells of various forms, mostly small, round epithelial cells, spindle formed, and the leprosy cells. These are mostly large, round or oval cells, with many nuclei and vacuoles. They contain the leprosy bacilli. These cells are diagnostic of the disease and are found most numerous in the tubercles and nodules of leprosy. Neisser observed the gradation in the development of the lepra cell in size and contained nuclei and bacilli, also the degenerative lesion showing numerous extra-cell bacilli. Virchow, Neisser, Gerlitz, and others argue the consistent type of the lepra cell as the container of the bacilli, the exception being

FIG. 4.



B, bacilli in groups; ZZ, zooglia masses—giant cells; C, chains of bacilli. (Leloir.)

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¹*Die Krankheiten der Warmen Länder*, IIIer aufl., Jena, 1903, pp. 320–392. (With a very complete bibliography.)

against the rule; Unna is the chief protagonist of the "extra" cell theory, claiming that the lepra cell is only a mass of agglutinated bacilli, which are habitually aggregated in the lymph spaces.

In the trophic, or nerve type, the changes are found in the peripheral nerve trunks and their cutaneous branches, the central changes occurring secondary to general changes or infection. The leprous deposits are especially found in nodules along the ulnar, median, radial, musculo-cutaneous, intercostal, humeral and peroneal nerves. Thickening of the nerve is common. The trophic changes follow the invasion of the nerve itself by the bacilli.

Symptoms.—The uncertainty of fixing any particular period of incubation and the lack of observation of the early stages of the disease compel a study of the preliminary symptoms only upon the subjective history and after tangible manifestations are in evidence. Even in leprosy centres, suspicion of the disease arises only when local conditions appear and premonitory signs of the disease have been ignored. That these do exist many observers agree and the arrangement of these is based upon a supposed period of incubation, as this cannot be exactly known. The history of exposure is usually absent and, even when ascertainable, the length of time is too variable to admit of any accurate statement. This period varies from a few weeks to many years. Some instances are related in which twenty years had elapsed since known exposure to the disease had occurred. Continuous exposure over long periods has been noted, however, in the instance of several members of the same family or community being affected and here the prodromal symptoms have been studied.

The one most constant symptom is the occurrence of fever, intermittent and irregular in period and in type. Malaise, anorexia, dyspepsia, epistaxis, dryness of the nasal and respiratory passages, vertigo, headaches, neuralgias, pains in the arms and legs, and exaggerated functions of the fat and sweat glands are among the notable symptoms. The sweating is particularly striking, as it is periodical and evidently associated with nervous disturbances. There is in all instances a sense of anxiety, of anticipated calamity.

There may be marked hyperæsthesia of the skin, shown in areas of pruritic exaggeration with localized neuralgias. The intestinal tract may be disturbed by frequent diarrhœa and as a result it is quite usual for the patient to lose in weight.

So far as the specific manifestations are concerned, the usual diagrammatic method of resolving leprosy into fixed types is faulty and often misleading. While these certainly come under observation, the unusual cases are the rule. The evidences of leprosy are directly due to the invasion of the *Bacillus lepræ* and according as any particular organ or tissue is involved the symptoms are manifest. While any organ or tissue may be attacked, the vast majority of patients show the skin and the nerves as the selected sites.

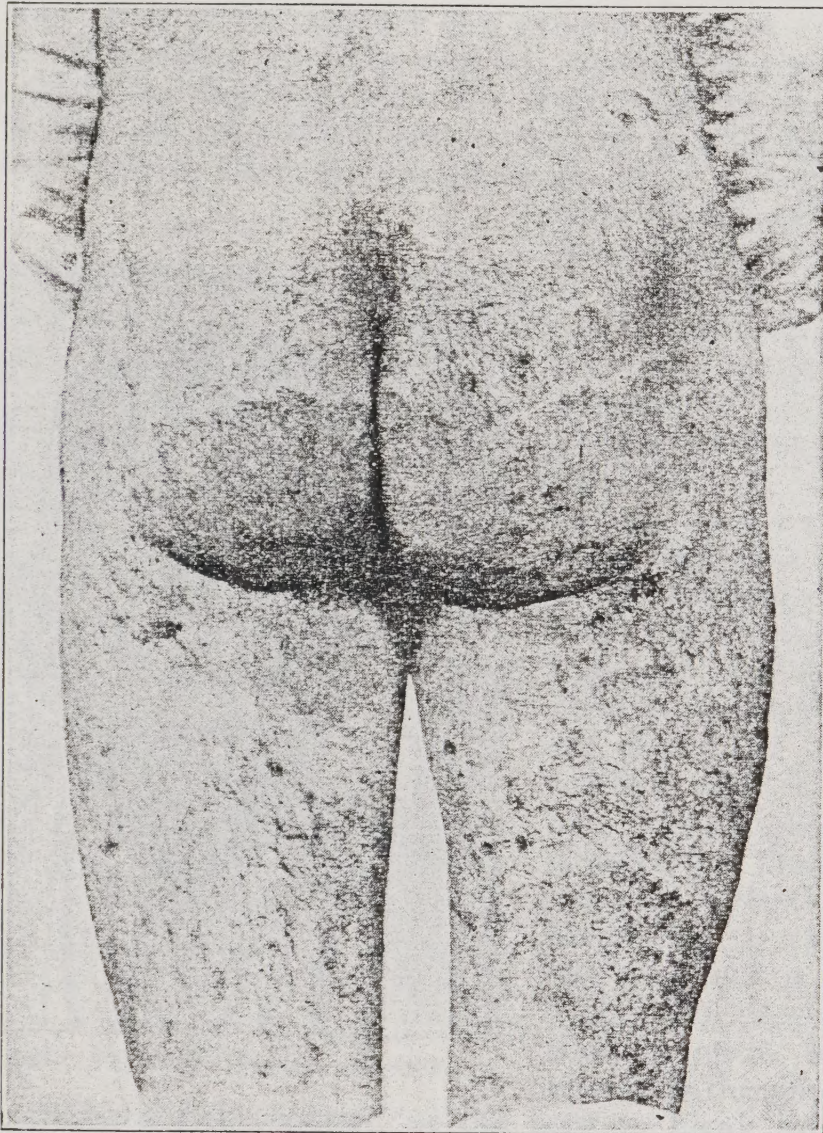
Dependent directly upon the degree of this invasion and upon the individual resistance, are the evidences in the skin and in the nerves themselves. In the history of every patient some logical course is followed in the expression of the disease but all do not follow exactly the same development. If the skin shows the first evidence, this may appear either in explosive lesions, as bullæ, in simple erythematous patches, or in exactly localized areas of bacilli colonized in masses and forming tubercles.

When the nerves are attacked, along the course of the nerve involved there is either thickening of the sheath or of the nerve itself, or nodes of varying

size are formed. At the terminal ends of the branches of these nerves, skin lesions in the form of bullæ, pigmentation, thickening or atrophy of the epidermis may appear or there may be actual neuritic changes in the muscles, tendons and bones.

Skin leprosy presents its several lesions either separately or together at the same time and while the macule often occurs as a preliminary eruption it may be the sole evidence of the disease. So with the tubercles of leprosy. These may appear at once or may develop upon the areas previously outlined by the erythematous or macular eruptions. All of these lesions may occur

FIG. 5.



Macules of leprosy. (Leloir.)

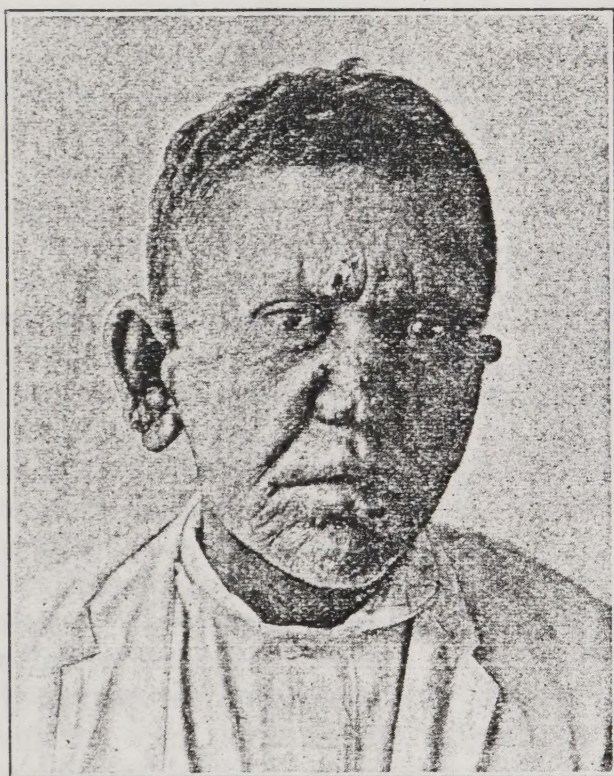
together and again they separately or together are often found concomitant with the nerve lesions and changes, which they may also precede or follow.

The first evidences of skin or nerve leprosy are the bullæ, found upon the extremities, especially on the hands and feet. With skin leprosy these are usually small in size, numerous and superficial. They occur bilaterally and symmetrically, usually on the dorsum of the hands and feet and especially over the fingers. They break quickly and dry, leaving a superficial erosion which heals spontaneously, and the site of the lesion is marked by a white scar, usually with a pigmented and irregular border.

With nerve leprosy these lesions are more often single, large, and occur over the joints of the phalanges; as a rule they persist, even ulcerating deeply at the point of origin. Even if healing should occur, there is a tendency for a new lesion to form at the site of the scar and ulceration develops, causing necrosis of the area affected. As any joint of any finger or of all fingers may be involved, the process may be progressively destructive, resulting in actual loss of one or more of the phalanges, either distal or intermediate. The process may start at the end of the digit, involve the nails, and result in the ultimate destruction of the whole digit, leaving the hand or the foot minus fingers or toes respectively.

The erythematous eruptions are evanescent or permanent. In the first instance they occur as the evidence of a general infection and come as an exanthem. They select particular regions, notably the cheeks, shoulders, buttocks, thighs and legs, sometimes the arms, forearms and hands. The eruption is bilateral, symmetrical and marked by an irregularity in the size of the areas involved, which are sometimes no larger than the thumb nail,

FIG. 6.



Satyriasis. Tubercular leprosy. (Cooper.)

while again the area may involve the whole of the region affected, as over the buttocks. The patches are deep red in color, do not fade entirely on pressure and have a suggestion of tumescence in a certain amount of elevation and rounding of the lesions. In a few days or weeks these disappear and may not recur. Oftenest, however, the areas over the buttocks, thighs, legs and shoulders remain defined as they first appear, growing dusky red in color, often mottled and thickening with age. The periphery grows more elevated and thickened, also increasing in depth of color to a brownish-red, while the centre fades to a buff or even to a dirty white. The patches grow somewhat elliptical in shape and remain in this general form and

with this consistency throughout, or the borders break up into distinct masses of tubercles, each representing a colonized accumulation of the bacilli. When the face is involved there is often confluence of the erythematous areas making a mask over the whole of the face, and involving the neck and ears. Here the thickening destroys the normal expression and produces a fixed, satyr-like appearance giving rise to the term "*satyriasis*," sometimes applied to the disease. The nose, ears, lips and eyelids become pendulous, occasioning a marked interference with the circulation and a consequent swelling. Ectropion follows and a bleary stare results. With the general thickening, the face rolls in folds and forms in parallel masses covered with a shining telangiectatic, smooth or tubercous, sometimes fis-

sured, skin; the lips grow swollen and everted and "*leontiasis*" has developed.

Nerve leprosy seldom extends beyond the developments of the disease at the extremities. Here and there along the ulnar and sciatic nerves and their branches, on the surface of the skin an erythematous eruption may appear, usually only temporary and expressing some fresh leproma of the nerve. Of course the processes in nerve leprosy may go on at the same time that skin leprosy develops and it is usual to see the one or other superimposed as the condition progresses. One rare instance of a correlation of nerve and skin leprosy is the atrophic type. Here, consequent upon the erythematous eruption and the pigmented areas, a general atrophy of the skin occurs, the muscular and keratin elements in large degree disappearing and leaving a true skin atrophy, with loss of the appendages, including the whole of the hair, the nails, and loss of function in the glands. Emaciation follows rapidly and death is swift.

Tubercle leprosy is essentially skin leprosy. The location of these lesions is not constant but they have sites of predilection. The face presents these on the forehead, nose, *alæ nasi*, lips, chin, cheeks and ears. The arch of the eyebrows is a frequent site. The hands and feet, legs, thighs, buttocks, shoulders and forearms are the next in order of frequency.

The leprosy tubercle may be single, clustered, disseminate or diffuse.

The single tubercle is usually large, more or less flat and found on the face, cheeks, hand or forearm; usually few occur. The color is bright brownish-red with the centre of the flattened lesion lighter than the border. The clustered tubercle is usually rounded, closely aggregated and selective of the *alæ nasi*, ears, chin, hands and lower third of the leg; the buttocks may also be involved. These lesions occur with a classical bilateral symmetry and are characterized by the almost olive and red color of the skin involved.

The *disseminate* leprosy tubercle is small, about the size of a pea, hard and round, uniform in size, occurring generally over the body, bilaterally and symmetrically; the lesions are separated by areas of clear skin and distinguished from all other tubercles by the waxy white appearance, as if white wax showed through a dirty brown transparent covering. Almost always this type of skin leprosy argues the occurrence of like lesions in the thoracic and abdominal viscera, as these cases rapidly become acute and result fatally in short order.

In each of the varieties of skin and nerve leprosy, and especially in the former, there are periods of quiescence and exacerbation. A striking feature in the periods of exacerbation is the "*lepra fever*" mentioned by a number of

FIG. 7.



Leontiasis. Terminal Stage of Tubercular Leprosy. (Cooper.)

observers. C. B. Cooper, Chairman of the Committee on Leprosy of the Hawaiian Government, has best described this phase of leprosy, although the condition seems more severe in his locality than elsewhere. He calls the condition "swollen head fever" as this was the term given it at the Hawaiian settlement at Molokai. He describes this as "an acute, epidemic, painful, inflammatory leprosy fever, in which the head and face become greatly swollen, and in which the lymphatic and glandular system becomes characteristically involved, especially the cervical and sometimes the axillary and

FIG. 8.



Single lesions. Tubercular Leprosy. (Cooper.)

inguinal glands as well." He was able to find the leprosy bacilli in the blood during the stage of fever. Concomitant with this condition is a typical lepra exanthem, differing from any of the eruptions above described. Cooper lays no stress on this, but, in the writer's observations at the Louisiana Leper Home, these were frequent enough to be considered important. The eruption consists in the occurrence, almost universally over the body, of bright red papules, lentil shaped and uniform in size, usually hyperæsthetic and at times painful, even severely so. With lessening of the general symptom, the eruption disappears, usually leaving, however, an increase in number in the previous lesions.

Altered Sensation.—So much stress is laid upon this that special

attention should be given to it. All skin lesions in leprosy excepting the evanescent erythema and the exanthem of papules in leprosy fever are anæsthetic to pain, sometimes to touch, heat and cold.

Hyperæsthesia is marked in the prodromal period and sensation is exaggerated in the exanthematous lesions. With nerve leprosy, hyperæsthesia is marked for weeks and months before the evidence of an affected nerve is complete. This is shown in pain along the extremity and in the hands and feet. Often distinct points of pain are recognized. As soon as the nerve is thickened and the nodes are formed, anæsthesia becomes complete along the areas of cutaneous distribution of the nerve involved. Usually the anæsthesia begins at the distal end of the nerve and travels toward the source. The little finger is usually the first point of anæsthesia noticed, and more often on the left side.

Effete Leprosy.—The leprosy in Brittany and that in the Orient, as well as many cases found in old leprosy centres, presents types which seem to show no acute symptoms at all, but which evidence trophic changes of slow development and unattended with inflammatory processes. Zambaco-Pacha and von Duhring have described these and most of them are of pure tropho-neurotic type. They present the claw-hand, loss of phalanges, facial paralysis, etc., usually considered as sequelæ of nerve leprosy.

Sequelæ.—As the direct result of leprous changes in the body, destructive processes in the internal organs, ultimately producing death, may result. Hillis tabulates the causes of death as marasmus (38 per cent.), septicæmia

FIG. 9.



Nodular leprosy. (Cooper.)

or intercurrent disease, as nephritis, (22.5 per cent.), pulmonary diseases, including tuberculosis, (17 per cent.), diarrhœa (10 per cent.), anæmia (5 per cent.), remittent fever (5 per cent.), and peritonitis (2.5 per cent.).

The natural necrosis, attending the final degeneration of tubercles, results in the loss of the nasal bones, often of the nose itself; in the ulceration on the face and in involved areas there is scarring, with contracting cicatrices, producing facial and other deformity. Most trophic nerve types develop one or more ulcers at the extremities, with consequent destruction of tissue. According to the limit of the process there may be simple contraction of muscles, atrophy of bones and subsequent deformity, or the whole of the member involved may slough off.

Diagnosis.—The customary observer of leprosy needs little aid to a diagnosis, as the facies, the color, and the classic lesions are well known to him. So much responsibility, however, rests in determining leprosy that due care should be exercised by those to whom it is a casual disease.

The diagnosis is absolute when destructive lesions exist in which the *lepra bacillus* may be demonstrated in section, in the fluid contents, or in culture. Clinically there should be little difficulty if the cardinal features of the disease are kept in mind. The essential points may be summarized as follows:

1. The habitat, community or domicile, suggesting exposure.
2. A history of exposure or contact with persons affected.
3. Eruptions or bullæ on the extremities.
4. Areas of discoloration with anæsthesia.
5. Trophic disturbances: (a) Perforating ulcers; (b) muscle atrophy, especially of the hands, determining the "claw-hand"; (c) clubbed fingers; (d) deformity of the hands and feet from loss of phalanges; (e) persistent ulcers at the articulations of the phalanges of the fingers and toes; (f) facial paralysis.
6. Discolored and blunted nails.
7. Symmetrical eruption of macular areas with bilateral distribution: (a) Marked by dusky red or "café-au-lait" discoloration; (b) with elliptical shape, the peripheral ring being elevated and deeply pigmented, while the

FIG. 10.



Trophic leprosy. (Leloir.)

centre remains lighter or a dirty white in color; (c) marked anæsthesia throughout these macular areas; (d) a predilection for particular regions, notably the buttocks, legs and forearms.

8. Tubercles with typical modes of appearing and of distribution.
9. Loss of expression in the face; satyriasis, leontiasis; ectropion of eyelids and of lips; furtive look in the eyes.
10. The early involvement of the nasopharynx and the larynx, resulting in a characteristic involvement of the vocal cords, determining a peculiar metallic resonance in the speech which is distinctive. The note is nasal and raucous.

Particular diseases mistaken for leprosy are few and the differentiation easy:

Erythema multiforme presents lesions which are evanescent, fade on pressure without pigmentation and are not anæsthetic.

Syphilis is differentiated by the color of the lesions, the symmetrical distribution of the leprous tubercles, their anæsthesia and course of development.

Sarcoma (multiple) by the pain, the size and course of development, the color and consistency.

Lupus vulgaris by the color, distribution, consistency and method of development of the lesions. The examination of the section or culture is sometimes necessary.

Morphæa by the absence of anæsthesia, and the color.

Raynaud's disease by the progressive ulcerative process, limited to the extremity involved, and by the absence of the nerve trunk involvement. The leprous perforating ulcer is nauseating; the ulcerating lesions of Raynaud's disease are simply offensive in odor.

FIG. 11.



Claw hand (Griffe) of nerve leprosy. (Leloir.)

Syringomyelia.—So many observers have related cases of leprosy possessing all the features of this disease and it so often occurs that cases diagnosed as syringomyelia are subsequently proven leprous that it is impossible to differentiate these except through finding the lepra bacillus, or postmortem evidence of changes in the cord without leprous involvement.

Prognosis.—Leprosy is like all other bacillary and infectious diseases; it is self-limited. Its evidences may last for years, or only for weeks or months. Often the disease will have periods of abeyance and exacerbation. Most often the course is run to a fatal issue or the victim may present scars or mutilation as the final expression of the spent morbid process. The

average duration is about eight years. The mixed and tubercular are the more rapidly concluded, in from four to twelve years, unless shortened by some intercurrent disease. The spontaneous involution of lesions may be followed by no recurrences, but this is usually only a process in the final result, though the longevity of the individual may be increased by this remission.

Treatment.—Until recent years the sole treatment was directed to sanitary control, in some countries administered under barbaric restrictions and methods. To-day most countries afflicted with the disease are provided with hospitals and asylums, the majority of these being under hygienic regulations so far as habit and food are concerned. Only a few leper institutions maintain systematic medical supervision of the disease itself, but the inclination is to expand the measures of amelioration for the inmates. In some asylums where leprosy has been studied and treated, a direct result has been obtained in a reasonable time. In some instances leprosy has been reported cured. This is true of the work of Rost in India, Goldschmidt in Trinidad, Tonkin in Jamaica, Carrasquilla in Colombia, and of the work in Louisiana. Besides this, individual cases are occasionally reported as cured. The most striking thing in the reported cures is the variety of remedial measures employed. From the radical sanitary and individual measures employed in the time of Moses down to the latest serum devised by Rost, the number of leprosy remedies has grown vastly. We cannot as yet proclaim a specific but we may draw deductions as to the therapeutic indications.

In all cases under treatment the progress in amelioration is slow. On the other hand, the disease may be absolutely self-limited without treatment, the evidences disappearing without a relapse or recurrence. The result of treatment depends directly upon the individual patient and upon the resistance he possesses or may acquire against the morbid process.

The treatments which have availed most have been supportive and hygienic. Drastic or reducing methods aimed at specific action have been temporarily remedial, but the disease re-awakens usually in the depleted subject. Serum treatment has been attempted, but hitherto has been successful almost solely in the hands of the one introducing it. Rost's serum is too new to have a final judgment.

The treatment of leprosy may be arranged in several divisions according to the method employed, *viz.*: alterative; supportive; empirical; serum; sanitary; and surgical.

The alterative treatment has been based upon the idea that such medication would reduce hyperplastic conditions and aid their absorption. Remedies so employed have been bichloride of mercury (Crocker), salicylate of soda and salol (Hawaiian Islands), euophen (Goldschmidt), chlorate of potash (Chisolm, Carreau) and the iodine salts. The results have been variable, though Crocker has reported 2 cases and Hutchinson 1 case evidently cured by hypodermic injections of the bichloride of mercury; Goldschmidt used euophen hypodermically successfully and Gruenfeld of Odessa confirmed this result; all of these cases have been isolated instances, however, arguing the first conclusion that the resistance is the essential factor.

Supportive or tonic treatment includes such remedies as hoangnan, strychnine, arsenic (Hutchinson and G. H. Fox), mercurial salts, general tonics, each of these having a particular champion for the time being.

Empirical treatment has had a continuous history, even to the present when every now and then some new discovery is brought out. That much

good has been accumulated by experimental use of remedies is true, but no exact deductions have been drawn in the study of those measures.

India has supplied most of the drugs employed. Chaulmoogra oil seems to have survived almost all the other herbaceous remedies and is now extensively employed universally. While this may stand as an empirical remedy it must also be considered as supportive, as the oil is in large part assimilated. The dosage depends upon the patient, but to be effective this should be increased to 100 to 150 drops at the dose, or 300 to 450 drops a day. Beginning with 3 to 5 drops of the oil in capsule, coffee, hot milk, or cordial, the dose may be increased gradually to tolerance. The oil may be given in pill form, combined with tonics, as iron, arsenic and strychnine or nux vomica. The consensus of opinion places chaulmoogra oil first among all remedies hitherto suggested. More cures have resulted from its use than from any other one remedy, and within a few weeks after its use amelioration is noted, even in advanced cases.

South America has contributed two remedies, assacon (*Hura braziliensis* Martin) and tua-tua, both used in the green state by macerating the leaves or berries and giving the resulting liquid. The reports on these are meagre and questionable. The red mangrove, or mangle, has been used in Key West and Havana. First suggested by a Key West druggist, this remedy was extensively exploited by M. Duqué of Havana. The powdered bark and root, used in tincture or pill, and also employed in the bath, were experimented with. Only one patient was relieved of symptoms by this treatment and doubt was thrown on this because of previous treatment with chaulmoogra oil.

Ichthyol and the mixed toxins of erysipelas, tuberculosis and vaccinia, are among other empirical remedies without marked result. Unna reported improvement under ichthyol but he abandoned this for chaulmoogra oil.

The Fiji Islands practice a scorching process which has its merits: the patient is placed upon a pyre of green leaves of a tree supposed to be specific against leprosy. In the slow process of cooking which the skin receives, the disease is supposed to disappear, and if the victim survives, he is expected to recover.

The West Indies and some parts of South America carry the superstition that the bite of a venomous reptile will cure leprosy and occasionally a native victimizes himself to this end. Influenced by the report of the condition resulting from the accidental biting of a leper by a viper in the West Indies the writer used the antivenomous serum of Calmette in a series of patients, with almost uniform good results. Three of the patients recovered. Injections were made at frequent intervals, sometimes daily, and the dosage varied from 5 to 20 cc. The buttocks and the shoulders were the usual sites of injection, though frequent injections were made in the lesions themselves, with the interesting result that these were directly influenced to favorable resolution. The cost of the treatment precluded extensive experimentation, so normal horse serum was employed in the same manner in a new series of cases but without result.

The sera of Carrasquilla and of Laverde, derived from the leprosy bacillus and tissues, may be mentioned. Both were successful to a greater or less degree at the hands of the originators, but failed elsewhere. Quite recently a new serum has been introduced by Rost of the Indian Medical Service. This, which he calls "leprolin," is derived from a toxin of the *Bacillus lepræ*.

Cultures of the lepra bacilli in special media were allowed to grow for six weeks at a temperature of 37° C., then sterilized and passed through a Pasteur filter, when glycerine was added. The dose of leprolin is 10 cc., equivalent to 50 cc. of pure culture of the bacillus. The injection should be made into the muscles of the buttocks or of the arm. Two or three days is the usual interval, but both the dosage and the interval are regulated by the reaction and the dosage is increased if a reaction of 100° F. does not occur. By increasing the dose in this way a proportionate improvement has been observed. Leprolin is contra-indicated where pulmonary or kidney complications are present. In conjunction with the treatment, salt is freely administered and equal parts of salt and vaseline are rubbed into the anæsthetic areas.

In every patient under treatment, marked improvement was noted and of 120 cases treated, 14 were discharged as cured, and a number of others are rapidly recovering sensation with loss of leprous evidences. Unfortunately no confirmatory experimentation has been possible, owing to the limited supply of serum, but the published results are most encouraging.

Treatment resolves itself into the essential fact that the disease is one in which a method of reconstruction is necessary, based upon hygiene, diet, and medication. Experimental treatment should be secondary to well-known practice and only where evidence of improvement under recognized treatment is absent. Treatment above all must be constant and the patience of both physician and the patient must be great.

The regular practice with the writer is to insist upon daily hot alkaline baths, a liberal diet without indigestible food, and a regular dosage with strychnine in $\frac{1}{60}$ to $\frac{1}{30}$ gr. doses (1 to 2 milligrams). Arsenic, iron, the phosphates, olive oil, etc., are given selectively. The majority of patients are treated with chaulmoogra oil, but now and then some other treatment is indicated. Under this general regime, 12 cases of leprosy have been cured since 1894, (10 of these have already been reported¹).

Surgical treatment is directed at the condition present and consists in amputations, nerve stretching and electrotherapy. The use of x-ray treatment may be mentioned. Gilchrist succeeded in reducing the tubercles after a number of exposures. Similar reports have emanated from the Philippines but as yet radiotherapy must be entertained only as an aid.

So far as concerns the United States in the general sanitary care of leprosy, Congress has enacted several bills, directed at the investigation of the disease, and in February, 1905, a bill was entertained looking to a national leprosarium. As yet nothing has come of this. Meantime, Louisiana regularly cares for her lepers in a model home under hygienic and systematic medical administration. The rest of the United States takes little interest in the subject, excepting San Francisco, where a large Chinese contingent compels a system of segregation. Massachusetts has established a temporary asylum for five lepers on an island in Boston Harbor.

Earnest effort throughout the world promises relief from the disease in one or another way—either by obliterating it by segregation or of finding a panacea.

¹ *Medical News*, New York, July 29, 1905.

